B1 Cont.

a processor operable to iteratively process said digital values to determine said information and place said information in locations within said matrix;

a phase multiplier operable to multiply signal-only data from said processor with a plurality of phase values and output phase multiplied data; and

a combiner operable to combine said phase multiplied data.

A1 Cont.

13. A receive system according to claim 12 further comprising;

a local oscillator operable to generate a reference signal; and

a mixer operable to heterodyne said reference signal with said overall receive signals to generate a lower frequency version of said overall received signals.

Sub B1

14. A receive system according to claim 12, wherein a zero phase reference is established that is synchronized to a system timing generator from which reference in-phase (I) and quadrature (Q) components are established, said I and Q components being processed independently.

15. A receive system according to claim 12 wherein said analog to digital converter is further operable to separately generate digital in-phase and quadrature samples of said overall receive signals wherein said quadrature samples are approximately 90 degrees out of phase with respect to said in-phase samples.

Sub B1

16. A receive system according to claim 12 wherein said antenna comprises a two-dimensional array of elements grouped into a plurality of corresponding right-left groups, each

Cont.

B1 Concl.

right-left group being centered around a center group wherein each of said elements is spaced an integer multiple of a half-wavelength from a respective adjacent element.

A1 Cont.

17. A receive system according to claim 12 wherein in-phase (I) and quadrature (Q) signal processing effectively removes any affects of an inherent signal phase, Beta, and an electrical phase angle, phi, is obtained that corresponds to a physical angle, theta, which is approximately equal to a phase difference between a normal to the antenna and a receive angle of said overall receive signals, to measure the electrical phase angle, phi, of said receive signal.

18. A receive system according to claim 12 wherein said phase multiplier multiplies a phase difference, phi, by a plurality of integers, said phase difference being the difference between a real phase of said received signals and a theoretical phase of said received signals, said theoretical phase being determined from a receive angle of said overall receive signals.

19. A receive system according to claim 12 wherein a plurality of outputs from said phase multiplier are coherently combined to increase an angular sensitivity of the receive system.

20. A method of improving the directivity of a receive system, said method comprising the steps of:

receiving receive signals from an antenna array, said antenna array comprising a plurality of elements;

amplifying said receive signals to form amplified signal-plus-noise signals;

determining a phi-phase equivalent to a difference between a reference phase and a phase of said amplified signal-plus-noise signals;

forming in-phase and quadrature versions of said amplified signal-plus-noise signals by subtracting said phi-phase from said phase of said amplified signal-plus-noise signals to form said in-phase version and adding or subtracting about ninety degrees from said in-phase version to form said quadrature version;

A1 Cont.

determining a phase difference between respective receive signals received from adjacent elements of said antenna array and an amplitude of said receive signal received from each element of said antenna array;

multiplying said phase difference by each of a series of integers to create a plurality of outputs;

summing said outputs coherently to form an improved overall output with an improved sensitivity substantially greater than a normal sensitivity of said receive signals; and

computing the arctangent of a noise reduced quadrature signal divided by a noise reduced in-phase signal to constitute an angle, phi, of the signal.

21. A method for increasing the signal to noise ratio of a receive system, said method comprising the steps of:

receiving receive signals from an antenna array, said antenna array comprising a plurality of elements;

amplifying said receive signals to form amplified signal-plus-noise signals;

creating in-phase and quadrature versions of said receive signals wherein said in-phase and quadrature versions are about ninety degrees out of phase with respect to each other;

A1 Cont.

determining an average noise and an average signal of said amplified signal-plus-noise signals;

forming separate matrices each associated with either said in-phase or said quadrature versions of said receive signal, said matrices digitally representing a plurality of values, said values consisting of said in-phase or quadrature versions of said receive signals received from each element and a deviation of said in-phase or quadrature versions of said receive signals from said average noise; and

selecting an amplified signal-plus-noise signal with a minimum deviation from said average noise; and performing an iterative process on data contained in said matrices to determine an estimate of the magnitude and polarity of the noise portion of the signal plus noise for each trial.

22. The method according to claim 21, further comprising the steps of:

storing and delaying the receive signals;

calculating an estimate of a noise-only portion of in-phase and quadrature components of said receive signal by using a converging iterative process to obtain an in-phase noise estimate and a separate quadrature noise estimate; and

subtracting said noise-only portion of said receive signal from delayed signals to form a signal-only portion of said receive signal.

Sub B17 Cont.

23. A receive system comprising an antenna array with two interoperable arrangements of elements, said antenna array operable to provide signal-plus-noise outputs to an iterative processing method,

said iterative processing method being capable of;

achieving dramatic signal-to-noise ratio improvement,

improving the ability to distinguish weak signals received by said antenna array antennae array, and

improving angular discrimination by sharpening a beam of said antenna array,

wherein said angular discrimination is improved by a phase multiplying process using two or more groups of said receive signals, each group having a separation of different numbers of half wavelengths.

A1 Cont., B1 Concl

24. A method of improving an angular resolution in a receive system, said method comprising the steps of:

aggregating signal-plus-noise data output from an antenna into a plurality of groups, each group containing data having a similar phase, wherein the phase corresponding to each group is a multiple of the phase corresponding to the other groups, said multiple being determined by a spacing between the right and left elements of each group from the center of the antenna array.

25. A method as claimed in claim 24 wherein said groups are formed by combining data from respective right and left antenna elements and wherein said right and left antenna elements are equidistant from a central common reference located at a center of the array of elements and corresponding to a phase angle, phi, of zero phase.

Sub B17 Cont.

26. A method as claimed in claim 24, said method further comprising the steps of:

B1 cont.

iteratively processing the data in said group to reduce a noise portion of a signal plus noise average to derive a relatively noise-free representation of the angle, phi, associated with an arrival direction of the signal from said group.

A1 Cont.

27. A method as claimed in claim 24, said method further comprising the steps of:

phase multiplying said angle, phi, from each group; and

processing the resulting vectors from the phase multiplying step from all of the groups in order to provide improved angular discrimination against signals from unwanted angle directions outside a resultant sharpened beam.

28. A method as claimed in claim 26, wherein said iterative processing step includes the step of sequentially applying a series of digital values to said data to alter a value representing signal plus noise with the result of each iteration to obtain an estimate of a noise portion of the signal plus noise by algebraically summing values of the several iterative steps.

Sub B1

29. A method as claimed in claim 26, wherein said iterative processing step includes;

sensing, in a bipolar manner, a change in the data, caused during each iteration,

wherein a magnitude of the change is determined equally for both plus and minus values of the noise component of the signal-plus-noise samples in a symmetrical bipolar manner and the result of each iterative value applied is assessed to determine the next subsequent value in a way that constitutes an overall feedback system.

30. A process for substantially improving the signal to noise ratio of a receive system, said process comprising the step of:

iteratively converging on an estimate of a noise-only portion of received signals plus noise for both in-phase and quadrature components of said received signals plus noise by simultaneously obtaining said noise-only estimates from a net algebraic sum of a series of iterations which provides a close approximations to the magnitude of the noise for each trial, and of opposite polarity;

A1 Cont.

reducing the actual noise of said received signals plus noise by subtracting said close approximations from said received signals plus noise.

31. The process for substantially improving the signal to noise ratio of a receive system claimed in claim 30, said process further comprising the steps of:

storing selected signal plus noise data;

comparing said noise-only estimates of each iteration of each trial from each group and using a result of said comparison to remove most of the noise from each signal plus noise value that was stored in said storing and delaying steps.

Sub B17

32. The process claimed in claim 31, wherein the signal plus noise is sampled at the Nyquist rate and the total iterative process of several iterations is accomplished at a rate lower than the Nyquist rate to achieve non real-time performance, the lower rate being accomplished by division of a sample clock frequency by a divisor ratio to achieve a prescribed known rate and a fixed tolerable time delay.

33. The process claimed in claim 32, wherein a bandwidth and a signal handling capability of said receive system are not adversely compromised but rather the process results in a known delay from real time, wherein the predetermined delay is dependent upon the selection of an appropriate processing speed and the fixed delay time is utilized as a processing time to improve the signal-to-noise ratio of said system.

A1 Cont. Sub B1

34. A receive system comprising;

an antenna array with right and left side elements operable to receive signal-plus-noise signals;

a means for aggregating outputs of selected right and left side elements of said antenna array to form an aggregation of signal-plus-noise voltages in digital form, said digital values being appropriate for forming aggregations in a form to perform subsequent near-real time iterative processing.

35. The receive system as claimed in claim 34 further comprising:

a processor operable to identify a particular entry of a subset of said aggregation that has the least absolute deviation from an average of the subset,

wherein said identified entry represents an entry whose noise is closest to the average noise component of the signal plus noise average of the aggregate group.

36. The receive system as claimed in claim 35 wherein said subset includes separate in-phase (I) and quadrature (Q) voltage outputs and provides the signal and noise in a first row of

a two row numerical array of digital numbers with a second row consisting of the signal plus noise average for each of the separate I and Q aggregations.

37. The receive system as claimed in claim 36 further comprising:

A1 Cont.

a modification device operable to modify the signal plus noise outputs of said two row numerical array, wherein said modification is performed by adding progressive and contiguous predetermined values both plus and minus over a pertinent range so that a relatively large number of different entries are formed that constitute columns of a matrix containing an array of numbers in which each column corresponds to a plus or minus value of the added or injected value whose polarity is opposite to that of the noise, and wherein further, the total array provides a topological representation or map of the totality of appropriate signal plus noise values as segregated by column location for each row.

Sub B17 Cont.

38. A receive system comprising;

an antenna array with right and left side elements operable to receive signal-plus-noise signals;

a deviation determining device operable to select datapoints, representing data from each of said antenna array elements, and arrange said datapoints in a sextet, octet or other evenly distributed group for each in-phase (I) and quadrature (Q) representation of said signal-plus-noise signal,

wherein said device determines a deviation for each individual datapoint of said sextet, octet or other evenly distributed group, from the average of each group to determine which datapoint constitutes a minimum absolute value of said deviations from said average, said

deviation and said average being used to form a topological map of numbers that correspond to modified numbers produced by adding pre-programmed values to said data.

B1 Concl.

39. A method of processing signals received by a receiving system, said method comprising:

A1 Cont.

forming left and right topological groupings of digital representations of said signals, said groupings formed about a topocentric reference that corresponds to a zero value injection from a stored predetermined value injection pattern comprised of positive and negative steps, which are incrementally increasing in magnitude, in each of two or more rows of similar increments having a common topocentric zero reference.

40. A method of processing signals received by a receiving system according to claim 39, wherein said increasing positive and negative steps are associated with said groupings in reverse order, from minus to plus in one of the two, or more, rows to provide polarity senses that are opposite to each other to sharpen an error response of column entry comparisons.

Sub B17

41. A method of processing signals received by an array of a receiving system, said method comprising;

Cont.

configuring a numerical array of modified signal-plus-noise values representative of said received signals such that each noise portion of said signal-plus-noise value transitions through zero at a location in the array, said location being determined by the polarity and magnitude of said noise; and

sensing how the injection of a programmed iterative value will change a relative location within said array by sensing, in progressive steps, when each injected iterative value causes a match in the numerical values of signal-plus-noise from two rows of the numerical array to be further from, or closer to, a topocentric center of left and right portions of the array.

A1 Cont.

42. The method according to claim 41, further comprising:

providing equilibrium about a center of the array; and

sensing iterative changes in a symmetrical fashion in said modified signal-plus-noise values by using plus or minus deviations from an average row and a row corresponding to a plus or minus deviation nearest to the average,

wherein said equilibrium is achieved by imposing left or right incremental column shifts in the row corresponding to a plus or minus deviation nearest to the average and wherein said incremental shift corresponds to said deviation in terms of an incremental column spacing.

43. A method according to claim 42, wherein said left or right incremental shifts in said average row and said row corresponding to a plus or minus deviation nearest to the average are reversed with respect to each other in two pertinent rows.

44. A method according to claim 42 further comprising:

producing a sequence of controlled steps to create a series of discrete voltage values using an iterative program in which each value alters the signal plus noise value to create a new signal plus noise value for each entry of both left and right portions of the topographical numerical array.

A1 Cont.

45. A method according to claim 44 further comprising:

sensing how each iterative step alters the entries of selected rows of the topographical digital numerical array; and

determining when a numerical match of values occurs between various columns of said array.

46. A method according to claim 45 further comprising:

reading a column entry from the average row and the column in another row, different from said average row, that has been shifted by an amount equal to the algebraic sum of the minimum deviation value together with a left or right shift furnished as part of an instruction from said iterative program.

47. A method according to claim 45 further comprising:

establishing an initial reference at a zero column at a topocenter of the topological numerical array for the first iteration and thereafter using a resulting column location for each succeeding iteration to constitute the next reference column for each succeeding iteration.

Sub B17 Cont.

48. A method according to claim 47 further comprising:

determining in a bipolar manner when the polarity of the noise portion of a signal plus noise combination changes sign in response to a predetermined value injection; and

sensing deviations in the noise in the absence of knowledge regarding the polarity of the noise prior to said value injection,

B1 cont.

wherein said method is accomplished through use of a topographic digital number array that covers a plus and minus (i.e., bipolar) range and is in equilibrium about its topocentric value, which is zero.

A1 cont.

49. A method according to claim 48 further comprising:

iteratively processing said signals by employing the bipolar sensing property to respond to a series of programmed voltage injections, each voltage injection corresponding to a digital number, as provided by an iterative program that results in a process that converges in decreasing increments,

wherein an algebraic sum of appropriate amounts from each closed loop iterative voltage provides an equivalent noise voltage, which approximates an actual noise voltage portion for each signal plus noise sample.

50. A method according to claim 49 further comprising:

deriving an array of numbers by supplying a prescribed series of contiguous numbers that progressively alter an average of signal plus noise values of said received signals to provide a topographical map of numbers;

determining, from said topographical map of numbers when a noise portion of said signal plus noise values changes, or comes closer to changing its polarity, in response to an additional executed change in the form of column displacement or shift as provided by the iterative sequencing program; and

repeating said deriving and determining procedures while storing original signal plus noise values; and

initially matching the numerical value in the shifted column with that of the zero column and after each successive iterative step, matching the numerical value with an entry in a new column with that of the new "average" row column that results from the preceding step.

A Cont.

51. A method in accordance with claim 50,

wherein a response to the prior applied value step that results in a left or right column shift is a basis for the next step; and wherein further,

if said response is closer to zero, a step of the same polarity (or column shift) and of equal or diminished amount is used in the process; and

if the average row match has changed from one side of the topocentric or zero column to the opposite side, then a value with a polarity opposite to the polarity used in the previous step and reduced in amount is used in the process.

52. A method in accordance with claim 51, wherein each of said iterations forms a basis for a next iteration until successive iterations achieve an unlocking of information in the form of an estimate of an amount of unwanted noise.

53. A method in accordance with claim 22,

wherein the entropy of said receive system is improved by said iterative processing by providing increased order to the stored values that have been corrupted by noise and wherein an amount of said noise corruption is closely estimated by a converging process that converges in steps to yield an approximation thereby permits an improved signal-to-noise ratio to be attained for each sample.

54. A method according to claim 53, wherein said converging iterative process comprises:

delaying and storing the received signals to maintain the signal portion of the signals constant and wherein the variations that occur from one iteration to a next iteration consist primarily of changes in the noise portion of the signal.

A1 Cont

55. A method according to claim 46 further comprising:

holding a receive signal constant during a frame in time by using a memory device,

wherein said frame in time consists of a sum of several iteration times so that successive signal frames provide a noise-reduced modulated signal.

56. A method in accordance with claim 55 wherein each successive sample has the benefit of several iterations and accommodates modulation of various different signals for different applications and wherein a continuing sequence of frames of information is provided which comprise desired segments of a modulated signal with a noise portion of said modulated signal reduced and a desired modulated signal values are provided by a series of said frames of information.

57. An integrated circuit device operable to perform an iterative processing method, said device comprising:

means for injecting a series of predetermined digital values supplied by an Electrically Programmable Read Only Memory (EPROM);

means for storing new digital values resulting from said injection of digital values, said stored new digital values constituting a stored topographical number matrix in which two, or more, rows accommodate each of a plurality of trials of each of a plurality of iterative steps and wherein each iterative step introduces a number probe which causes a relative displacement between two rows, each of which contains column information, to afford an opportunity to match the stored entry values in two appropriate columns by a digital number comparator.

A1 Cont

58. A device according to claim 57 wherein the polarity and magnitude of a next iterative probe are determined to control a next iterative result and the algebraic sum of said probes values provides an accurate estimate of the polarity and magnitude of the noise portion of each separate iterative signal-to-noise sample thereby allowing the noise to be subtracted from the delayed signal-plus-noise input to yield an enhanced signal with reduced noise.

59. A device according to claim 58 wherein each frame of signal information is enhanced by several iterative steps that reduce the noise by providing the device with the information such that each iteration results in a noise value that is either closer to, or further from, a topocentric or zero reference of an array consisting of two, or more, rows, wherein one of the rows is displaced, or shifted, in column location by an amount corresponding to a dispersion amount (difference) between a noise average of a sextet or octet that provides the information from an antenna and the average of a similar entry that is closest to the noise average by comparing values in appropriate columns so that information regarding polarity and magnitude is derived with respect to each of a succession of iterative probes.

60. A device in accordance with claim 59 further comprising:

means for preserving and executing the number injections, sensing of the results in each of the two (or more) rows of the topographical number array to provide the results of selecting appropriate columns by matching nearly equal numerical column value entries from the two rows and repeating the above process for each iteration, starting each iteration with conditions resulting from the previous iteration.

A1 Cont.

61. An integrated circuit operable to provide frames of information as described in claim 56 to work in one or more pairs to form a parallel processing arrangement in which separate signal frames can be captured and stored simultaneously so that the output of each signal frame can be utilized individually and serially to construct a desired noise-reduced signal by successive frames that provide modulation characteristics of the sequence, wherein said processing arrangement is performed in a relatively short period of time manifested as a signal delay that does not compromise a bandwidth of the system.

62. A method according to claim 25 further comprising:

phase-gating of the angle, phi, of the received signal to accept only predetermined desired phases irrespective of random noise affects.

63. A receive system comprising:

means for achieving multiple simultaneous phase gates, each phase gate encompassing a predetermined segment of angular coverage at different angles corresponding to different signal directions in order to realize stacks of beams in azimuth and/or elevation angles

to constitute a cluster of enhanced beams covering multiple directions for reception of the signals.

64. A receive system according to claim 34 wherein a receptivity to radio frequency signals provides a signal strength, relative to inherent noise, characteristic that is equivalent to that which is expected from an antenna with a larger aperture, and wherein said signals have improved directivity and angular resolution over a wide range of radio frequencies permitting better utilization of an allocated or an independently chosen frequency spectrum.

A1 Cont'd

65. A method according to claim 33 further comprising iterative probing with bipolar sensing conducted in non-real-time to improve the entropy of the receive system.

66. A method according to claim 53 wherein the second law of thermodynamics is satisfied during a known delay from real time and an estimate of the noise portion of the signal plus noise is equivalent to introducing statistical mechanics energy at a lower temperature in a thermal system.

67. A method for increasing the signal to noise ratio of a receive wireline system, said method comprising the steps of:

receiving receive signals from a wire-line;

amplifying said receive signals to form amplified signal-plus-noise signals;

creating in-phase and quadrature digital versions of said receive signals wherein said in-phase and quadrature versions are about ninety degrees out of phase with respect to each other;

storing said signal-plus-noise signals in a memory device;

forming at least one matrix using said in-phase or said quadrature versions of said receive signal, said matrix digitally representing a plurality of values, said values consisting of said in-phase and quadrature versions of said receive signals;

performing an iterative process on data contained in said matrix to determine an estimate of the magnitude and polarity of the noise portion of the signal plus noise for each trial; and

subtracting each estimated noise value from the stored signal plus noise version to obtain a noise-reduced signal.

A1 Cncld

68. A method for increasing the signal to noise ratio of a receive fiber optic wireline system, said method comprising the steps of:

receiving receive signals from a fiber-optic carrier;

amplifying said receive signals to form amplified signal-plus-noise signals;

creating in-phase and quadrature digital versions of said receive signals wherein said in-phase and quadrature versions are about ninety degrees out of phase with respect to each other;

storing said signal-plus-noise signals in a memory device;

forming at least one matrix using said in-phase and said quadrature versions of said receive signal, said matrices digitally representing a plurality of values, said values consisting of said in-phase and quadrature versions of said receive signals;

performing an iterative process on data contained in said matrix to determine an estimate of the magnitude and polarity of the noise portion of the signal plus noise for each trial; and

subtracting each estimated noise value from the stored signal-plus-noise value to obtain a noise reduced signal.